

WHAT IS CLAIMED IS:

1. An apparatus for controlling recirculation of exhaust gas from an exhaust passage of an engine to an intake passage of the engine, the apparatus comprising:

a recirculation passage connecting the exhaust passage to the intake passage;

an EGR valve arranged in the recirculation passage, wherein the EGR valve varies its opening degree to adjust the amount of exhaust gas recirculated from the exhaust passage to the intake passage; and

a controller for controlling the EGR valve, wherein the controller obtains a target opening degree of the EGR valve in accordance with an operating state of the engine and controls the EGR valve so that the opening degree of the EGR valve becomes equal to the obtained target opening degree, and, when opening the EGR valve from a fully closed state, the controller performs EGR primary control to restrict the opening degree of the EGR valve to a restricted opening degree that is smaller than the target opening degree during a predetermined delay time before actuating the EGR valve to the target opening degree.

2. The apparatus according to claim 1, wherein the engine includes a supercharger driven by exhaust gas flowing through the exhaust passage to supercharge air in the intake passage.

3. The apparatus according to claim 2, wherein the supercharger is a variable geometry turbocharger.

4. The apparatus according to claim 1, wherein the EGR valve is driven by negative pressure, and the restricted

opening degree is set to a value included in an opening degree range in which chattering of the EGR valve does not occur.

5           5.    The apparatus according to claim 1, wherein the restricted opening degree is a constant value.

          6.    The apparatus according to claim 1, wherein the controller gradually varies the restricted opening degree  
10   during at least part of the delay time.

          7.    The apparatus according to claim 1, wherein the EGR primary control includes processing for maintaining the restricted opening degree at a constant value and processing  
15   for gradually increasing the restricted opening degree.

          8.    The apparatus according to claim 7, wherein the controller maintains the restricted opening degree at the constant value during a former part of the EGR primary  
20   control and gradually increases the restricted opening degree to the target value during a latter part of the EGR primary control.

          9.    The apparatus according to claim 1, wherein the  
25   restricted opening degree is a variable value.

          10.   The apparatus according to claim 9, wherein the controller sets the restricted opening degree in accordance with a parameter indicating the operating state of the  
30   engine.

          11.   The apparatus according to claim 1, wherein the delay time is the time required for eliminating an excessive

difference between an exhaust pressure of the exhaust passage and an intake pressure of the intake passage.

12. The apparatus according to claim 1, wherein the  
5 delay time is a constant value.

13. The apparatus according to claim 1, wherein the delay time is a variable value.

10 14. The apparatus according to claim 13, wherein the controller sets the delay time in accordance with a parameter indicating the operating state of the engine.

15 15. The apparatus according to claim 1, wherein the controller feedback controls the EGR valve so that the opening degree of the EGR valve becomes equal to the target opening degree, and the controller prohibits the feedback control when the EGR primary control is being performed.

20 16. An apparatus for controlling recirculation of exhaust gas from an exhaust passage of an engine to an intake passage of the engine, the apparatus comprising:  
a recirculation passage connecting the exhaust passage to the intake passage;

25 an EGR valve arranged in the recirculation passage, wherein the EGR valve varies its opening degree to adjust the amount of exhaust gas recirculated from the exhaust passage to the intake passage; and

a controller for controlling the EGR valve, wherein the  
30 controller obtains a target opening degree of the EGR valve in accordance with an operating state of the engine and controls the EGR valve so that the opening degree of the EGR valve becomes equal to the obtained target opening degree,

and, when opening the EGR valve from a fully closed state, the controller actuates the EGR valve to the target opening degree after a delay in time that is required for eliminating an excessive difference between an exhaust  
5 pressure of the exhaust passage and an intake pressure of the intake passage.

17. A method for controlling recirculation of exhaust gas from an exhaust passage of an engine to an intake  
10 passage of the engine, the method comprising:

varying an opening degree of the EGR valve to adjust the amount of exhaust gas recirculated from the exhaust passage to the intake passage through a recirculation passage;

15 obtaining a target opening degree of the EGR valve in accordance with an operating state of the engine;

controlling the EGR valve so that the opening degree of the EGR valve becomes equal to the obtained target opening degree; and

20 when opening the EGR valve from a fully closed state, restricting the opening degree of the EGR valve to a restricted opening degree that is smaller than the target opening degree during a predetermined delay time before actuating the EGR valve to the target opening degree.

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18. The method according to claim 17, wherein the restricted opening degree is a constant value.

19. The method according to claim 17, further  
30 comprising:

gradually varying the restricted opening degree during at least part of the delay time.

20. The method according to claim 17, wherein the EGR valve is feedback controlled so that the opening degree of the EGR valve becomes equal to the target opening degree, and the feedback control is prohibited during the delay  
5 time.